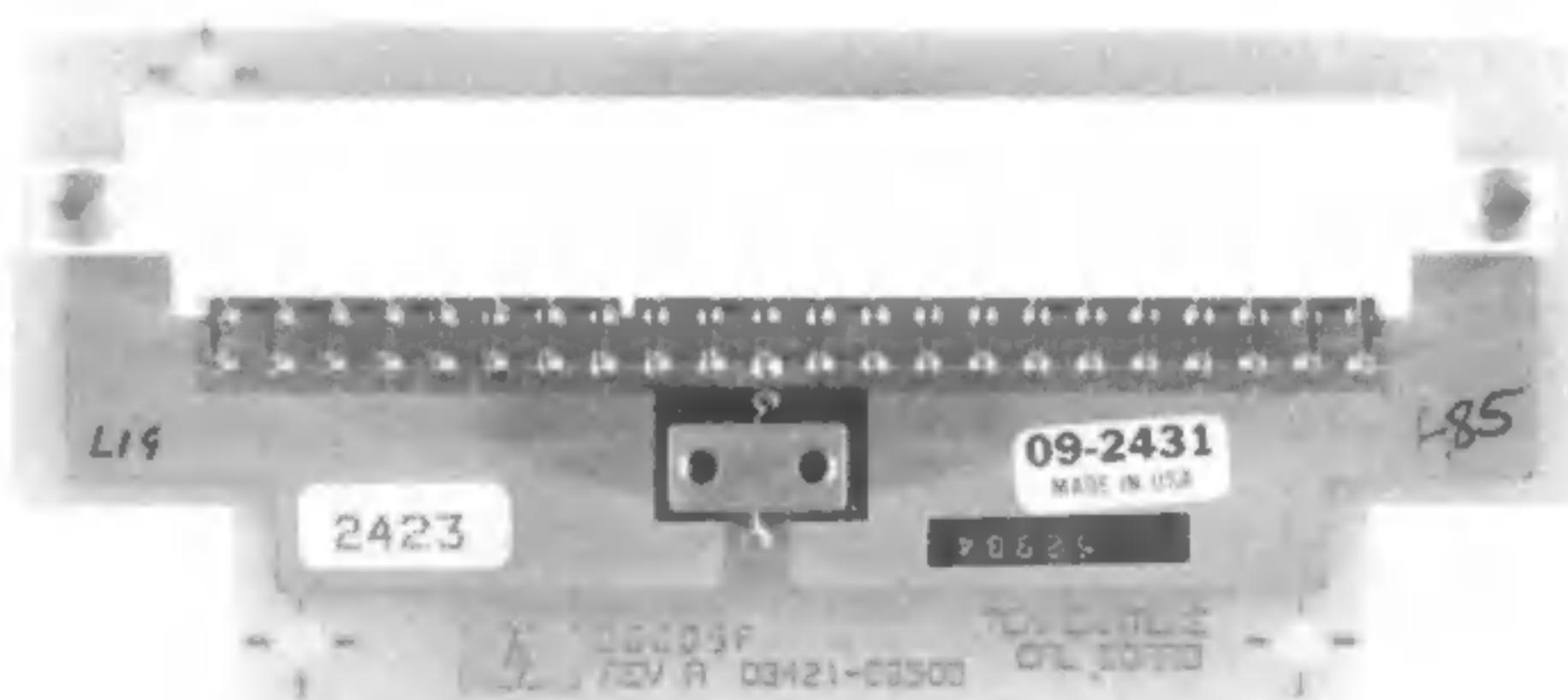


**HP 3421A  
OPERATING NOTE**

MANUAL TEMPERATURE CALIBRATION OF THE  
HP 44462A MULTIPLEXER/ACTUATOR ASSEMBLY  
USING THE 03421-66505 TEMPERATURE CALIBRATOR BOARD  
AND  
SEMI-AUTOMATED TEMPERATURE CALIBRATION OF THE  
HP 44462A MULTIPLEXER/ACTUATOR ASSEMBLY  
USING THE 03421-10001 TEST TAPE CARTRIDGE



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## INTRODUCTION

This operating note has manual temperature calibration and semi-automated temperature calibration procedures for the HP 3421A Data Acquisition Unit and the Model 44462A Multiplexer/Actuator Assembly (Options 020, 021, and 022). Semi-automated verification/calibration procedures for the HP 3421A and its options are also included.

## MANUAL TEMPERATURE CALIBRATION

The temperature calibration is for the HP 44462A Multiplexer/Actuator Assembly (HP 3421A Options 020, 021, and 022) and uses the HP 03421-66505 Temperature Calibrator Board. There are two procedures that can be used. The first uses the HP 3456A digital voltmeter while the second uses the HP 3421A internal voltmeter. The HP 3456A procedure is more convenient since the Model 3456A will automatically calculate the calibration temperature. In the Model 3421A calibration procedure, the calibration temperature must be calculated by the controller using a formula given in the discussion. Procedure steps are given for both the HP-85 and HP-41C/CV/CX controllers.

It is recommended that the temperature calibration be performed with the HP 3421A in the same physical position as it will be when used. That is, the Model 3421A should be calibrated after warming up for at least one hour while placed in the equipment orientation (rack mounted or stacked with peripherals and associated instruments) within which it will be used. Attempt to simulate this if necessary. It is important to take into account as many environmental influences upon the instrument temperature as possible.

### Recommended Equipment

The following equipment is recommended to perform the temperature calibration. The Temperature Calibrator Board (HP P/N 03421-66505) is presently shipped with all HP 3421As equipped with ■ Multiplexer/Actuator option (Option 020, 021, or 022), and all Multiplexer/Actuator Assemblies ordered separately (i.e., HP 44462A). It can also be ordered separately.

- HP-85 Computer with I/O ROM and HP-IL or HP-IB interface
- or
- HP-41C/CV/CX with HP-IL interface
- Temperature Calibrator Board (P/N 03421-66505)
- HP 3456A Digital Voltmeter (for the 3456A procedure only)

### NOTE

*If there is more than one HP 44462A Multiplexer/Actuator Assembly in your instrument, you can simultaneously calibrate all the assemblies using a separate 03421-66505 Temperature Calibrator Board for each assembly instead of one board for all assemblies. If this is done, only one warm-up is required for all the assemblies instead of a one-hour warm-up for each individual assembly.*

### Temperature Calibration Using the HP 3456A

To calibrate the temperature function using the HP 3456A, perform the following procedure. The semi-automated test and calibration procedures described later in this operating note can be used instead of the following manual procedure, if the HP 3421A Calibration and Performance Verification Tape (P/N 03421-10001 REV C) is available. (Note: Revisions prior to REV C are not designed to operate with the Temperature Calibrator Board.)

- a. Identify the slot or slots with a Multiplexer/Actuator Assembly to be calibrated (slots 0, 1, and/or 2).



*In this procedure you are directed to remove power from the HP 3421A. Always make sure the calibration enable switch (S501 segment #8) is in the up position before the Model 3421A front panel switch is pressed off or AC power is disconnected. Failure to do this could cause the calibration RAM constants to be altered requiring complete re-calibration of the instrument.*

*If an HP-IL controller is used that has the "Auto Off" feature, such as is available with the HP 71B and HP 75C/D (i.e., the controller automatically turns off if not used for a certain amount of time and in turning off executes a loop power-down), make sure the controller does not turn off when connected to the 3421A with the calibration enable switch in the down position. If the controller turns off, the 3421A may unexpectedly go into the power down mode. This could also cause the calibration RAM constants to be altered requiring complete re-calibration of the instrument.*

- b. Make sure the rear panel calibration enable switch (S501 segment #8) is in the up position. Then press the HP 3421A front panel switch to the off position and unplug the instrument's power cord.
- c. Remove the black rear panel strain relief bar on the slot(s) to be calibrated by loosening the two captive screws that hold each in place.
- d. Remove the gray "WARNING" safety cover(s) on the slot(s) to be calibrated by loosening the two captive screws that hold each in place.
- e. Loosen the two captive screws holding the terminal block(s) to the Multiplexer/Actuator Option board(s) and then remove the terminal block(s).
- f. Plug the Temperature Calibrator Board(s) (P/N 03421-66505) onto the Multiplexer/Actuator Assembly (or Assemblies) to be calibrated. Make sure the component side of the calibrator board is in the up position when plugging it onto the Multiplexer/Actuator Assembly.

g. Reinstall the gray "WARNING" safety cover(s) that was/were removed in step d. This ensures a more stable temperature for calibration.

h. Plug the HP 3421A power cord into an AC outlet and press the front panel switch on.

i. Allow the Model 3421A to warm-up for at least one hour.

j. Connect the HP 3456A HI and LO inputs to the HP 3421A 2 wire Ω/V HI and LO inputs, respectively.

k. Place the rear panel calibration enable switch (S501 segment #8) in the down position.

l. Close channel 4 of the Multiplexer/Actuator Assembly to be calibrated by executing the following line(s). Fill in the blank space with the appropriate channel number. If the Multiplexer/Actuator Assembly is in slot 0, send "CLS04". If it is in slot 1, send "CLS14". If it is in slot 2, send "CLS24".

#### **HP-85**

OUTPUT 901 ; "CLS\_\_\_\_"

#### **HP-41C/CV/CX**

**ALPHA CLS\_\_\_\_ ALPHA  
XEQ ALPHA OUTA ALPHA**

m. Select the appropriate function, range, and channel by executing the following program line(s). Fill in the blank space with the appropriate channel number. If the Multiplexer/Actuator Assembly is in slot 0, send "REF4". If it is in slot 1, send "REF14". If it is in slot 2, send "REF24".

OUTPUT 901 ; "REF\_\_\_\_"

**ALPHA REF\_\_\_\_ ALPHA  
XEQ ALPHA OUTA ALPHA**

n. If after sending the "REF\_\_\_\_" command an error is detected, the 3421A front panel LCD error indicator is on, the error is most likely caused by an uncalibrated Multiplexer/Actuator Assembly. The error should disappear after completing the temperature calibration (step p).

o. Using the HP 3456A 2-wire ohms function and temperature math function in °C, measure and note the temperature of the thermistor on the Temperature Calibrator Board. Press the following buttons on the Model 3456A to read the temperature.

2-WrΩ Function button  
Auto Range button  
Blue Math button on Keyboard  
"6" (i.e., THM°C) button on Keyboard

p. Execute the following line(s), filling in the blank spaces with the HP 3456A temperature reading. The decimal point in the temperature reading is optional. However, the two leading 0's (zeros) are necessary. For example, if the temperature reading is 27.95°C, send "C002795" or "C0027.95".

OUTPUT 901 ; "C\_\_\_\_"

**ALPHA C\_\_\_\_ ALPHA  
XEQ ALPHA OUTA ALPHA**

**NOTE**

*Be sure to wait at least 10 seconds after executing the "C\_\_\_\_\_ command, before disturbing the equipment set-up. This will ensure that the instrument has enough time to average ten readings and complete the calibration step properly.*

- q. After calibration is completed, send "REF\_\_\_\_" again and read the result to determine if any error occurred and to observe that the temperature is within the ambient temperature range (20°C to 30°C). If the temperature is out of the specified range, try the temperature calibration again. If an error is detected, go to the ERROR DETECTION paragraph in this note to determine what caused the error. Once the error is determined, perform the appropriate action as suggested in the paragraph.

OUTPUT 901 ; "REF\_\_\_\_"  
ENTER 901 ; T  
DISP T

**ALPHA REF\_\_\_\_ ALPHA  
XEQ ALPHA OUTA ALPHA  
XEQ ALPHA IND ALPHA**

- r. Repeat this procedure for each slot with a Multiplexer/Actuator Assembly requiring calibration, making sure to identify the correct channel address in steps l, m, and q.
- s. This completes the calibration procedure using the HP 3456A. Return the calibration enable switch (S501 segment #8) to the up position, unless you are going to perform another calibration procedure.

**Temperature Calibration Using the HP 3421A**

To calibrate the temperature function using the HP 3421A internal voltmeter, perform the following procedure. The semi-automated test and calibration procedures described in this operating note can be used instead of the following manual procedure, if the HP 3421A Calibration and Performance Verification Tape (P/N 03421-10001 REV C) is available. (Note: Revisions prior to REV C are not designed to operate with the Temperature Calibrator Board.)

- a. Identify the slot or slots with a Multiplexer/Actuator Assembly to be calibrated (slots 0, 1, and/or 2).
- b. Make sure the rear panel calibration enable switch (S501 segment #8) is in the up position. Then press the HP 3421A front panel switch to the off position and unplug the instrument's power cord.
- c. Remove the black rear panel strain relief bar on the slot(s) to be calibrated by loosening the two captive screws that hold each in place.
- d. Remove the gray "WARNING" safety cover(s) on the slot(s) to be calibrated by loosening the two captive screws that hold each in place.
- e. Loosen the two captive screws holding the terminal block(s) to the Multiplexer/Actuator Option board(s) and then remove the terminal block(s).



*In this procedure you are directed to remove power from the HP 3421A. Always make sure the calibration enable switch (S501 segment #8) is in the up position before the Model 3421A front panel switch is pressed off or AC power is disconnected. Failure to do this could cause the calibration RAM constants to be altered requiring complete re-calibration of the instrument.*

*If an HP-IL controller is used that has the "Auto Off" feature, such as is available with the HP 71B and HP 75C/D (i.e., the controller automatically turns off if not used for a certain amount of time and in turning off executes a loop power-down), make sure the controller does not turn off when connected to the HP 3421A with the calibration enable switch in the down position. If the controller turns off, the Model 3421A may unexpectedly go into the power down mode. This could also cause the calibration RAM constants to be altered requiring complete re-calibration of the instrument.*

- f. Plug the Temperature Calibrator Board(s) (P/N 03421-66505) onto the Multiplexer/Actuator Assembly (or Assemblies) to be calibrated. Make sure the component side of the calibrator board is in the up position when plugging it onto the Multiplexer/Actuator Assembly.
- g. Reinstall the gray "WARNING" safety cover(s) that was/were removed in step d. This ensures a more stable temperature for calibration.
- h. Plug the HP 3421A power cord into an AC outlet and press the front panel switch on.
- i. Allow the Model 3421A to warm-up for at least one hour.
- j. Key in and execute the following program. The program, as written, is set-up to measure the temperature of the Multiplexer/Actuator Assembly in slot 0. To measure the temperature of the assembly in slot 1, specify "TWO14". To measure the temperature of the assembly in slot 2, specify "TWO24".

#### HP-85

```
10 A = 1.285496378E-3
20 B = 2.360998857E-4
30 C = 9.324409398E-8
40 OUTPUT 901 ; "TWO4"
50 ENTER 901 ; R
60 D = 1/(A + B*LOG(R) + C*LOG(R)) - 273.16
70 D = INT(D*100 + .5)/100
80 DISP "TEMPERATURE IN DEGREES CELSIUS:";D
90 END
```

**HP-41C/CV/CX**

```

01 LBL "TEMP"
02 "TWO4"
03 XEQ "OUTA"
04 XEQ "IND"
05 LN
06 STO 10
07 3
08 Y↑X
09 9.324409398 E-8
10 *
11 RCL 10
12 2.360998857 E-4
13 *
14 +
15 1.285496378 E-3
16 +
17 1/X
18 273.16
19
20 .END.

```

- k. The controller should be displaying the temperature in °C.
- l. Place the rear panel calibration enable switch (S501 segment #8) in the down position.
- m. Select the appropriate function, range, and channel by executing the following line(s). Fill in the blank space with the appropriate channel number. If the Multiplexer/Actuator Assembly is in slot 0, send "REF4". If it is in slot 1, send "REF14". If it is in slot 2, send "REF24".

OUTPUT 901 ; "REF\_\_\_\_"

**ALPHA REF\_\_\_\_ ALPHA  
XEQ ALPHA OUTA ALPHA**

- n. If after sending the "REF\_\_\_\_" command an error is detected, the front panel LCD error indicator is on, the error is most likely caused by an uncalibrated Multiplexer/Actuator Assembly. The error should disappear after completing the temperature calibration (step o).

- o. Execute the following line(s), filling in the blank spaces with the temperature displayed on the controller (see step k). The decimal point in the temperature reading is optional. However, the two leading 0's (zeros) are necessary. For example, if the temperature reading is 27.95°C, send "C002795" or "C0027.95".

OUTPUT 901 ; "C\_\_\_\_\_"

**ALPHA C\_\_\_\_\_\_ ALPHA  
XEQ ALPHA OUTA ALPHA**

**NOTE**

*Be sure to wait at least 10 seconds after executing the "C\_\_\_\_\_"  
command, before disturbing the equipment set-up. This will ensure  
that the instrument has enough time to average ten readings and  
complete the calibration step properly.*

p. After calibration is completed, send "REF\_\_\_\_" and read the result to determine if an error occurred and to observe that the temperature is within the ambient temperature range (20°C to 30°C). If the temperature is out of the specified range, try the temperature calibration again. If an error is detected, go to the ERROR DETECTION paragraph in this note to determine what caused the error. Once the error is determined, perform the appropriate action as suggested in the paragraph.

OUTPUT 901 ; "REF\_\_\_\_"  
ENTER 901 ; T  
DISP T

**ALPHA REF\_\_\_\_ ALPHA  
XEQ ALPHA OUTA ALPHA  
XEQ ALPHA IND ALPHA**

q. Repeat this procedure for each slot with a Multiplexer/Actuator Assembly requiring calibration, making sure to identify the correct channel address in steps j, m, and p.

r. This completes the calibration procedure using the HP 3421A. Return the calibration enable switch (S501 segment #8) to the up position, unless you are going to perform another calibration procedure.

#### Error Detection

If the error indicator on the HP 3421A display turns on, you can determine the cause by reading the contents of the Status, Error, Hardware Error, and Calibration Error Registers. From this you can determine what is causing the error. Do this as follows:

a. When you execute the following line(s), the HP 3421A prepares a sequence of 24 numbers which are the values of the State Registers of the Model 3421A (see Figure 1 for a description of the first four registers).

OUTPUT 901 ; "SR"

**ALPHA SR ALPHA  
XEQ ALPHA OUTA ALPHA**

b. Since the HP 3421A errors are in the first four registers, input the contents of these registers to the controller by executing the following line(s). For the HP-85, the values will be read as follows: the contents of the Status Register into variable A, the Error Register into variable B, the Hardware Error Register into variable C, and the Calibration Error Register into variable D. The registers are then cleared in the HP 3421A and the display error indicator will be cleared immediately, if using HP-IL, or upon any subsequent I/O command if using HP-IB. If using the HP-41C/CV/CX, be sure to manually record the four values as they are returned.

ENTER 901 ; A,B,C,D

**XEQ ALPHA IND ALPHA  
XEQ ALPHA IND ALPHA  
XEQ ALPHA IND ALPHA  
XEQ ALPHA IND ALPHA**

c. Execute the following HP-85 commands to convert the numbers in variables A, B, C, and D from decimal to binary. The HP-85 should display a series of eight 1's and 0's for each variable. Each of these digits corresponds to one bit in the appropriate register. Note that there is no equivalent decimal to binary function for the HP-41C/CV/CX; the decimal place values shown in Figure 1 may aid in this conversion.

Read the Status Register bits in variable A:

```
A$ = DTB$(A)  
DISP A$[9]
```

Read the Error Register bits in variable B:

```
A$ = DTB$(B)  
DISP A$[9]
```

Read the Hardware Error Register bits in variable C:

```
A$ = DTB$(C)  
DISP A$[9]
```

Read the Calibration Error Register bits in variable D:

```
A$ = DTB$(D)  
DISP A$[9]
```

d. The right most digit in the HP-85 displays bit #0 with bits 1-7 numbered consecutively to the left of bit #0. Hand conversion of the register values returned with the HP-41C/CV/CX will provide identical results.

e. Use Figure 1 to identify the error condition. A condition is shown by a bit set to 1. For example, if bit 5 in Register 4 (Calibration Error Register) is ■ 1 (00100000), the calibration RAM is defective. If the error condition is in either Register 3 (Hardware Error Register) or in Register 4 (Calibration Error Register), go to Table 1 to determine possible causes of the error and appropriate action. Refer to the HP 3421A Mainframe Service Manual for detailed service procedures.

Register 1: Status Register							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Always 0	SRQ	Abnormal Condition	Low Battery	Event Occured	Self Test Error	Power-On Reset	Data Ready
128	64	32	16	8	4	2	1
Bit Value							
Register 2: Error Register							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Not Defined May be 1 or 0	Tried to load channel list with more than 30 channels	Can't do T3 since channel list is empty	Can't do TOT,MH,ML,MN,DT while battery is low	Option specified in command does not exist in that slot	Invalid Syntax	No data ready but addressed to talk	Triggered but F0 asserted
128	64	32	16	8	4	2	1
Bit Value							
Register 3: Hardware Error Register							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
10 Mohm test failed	RAM U503 failed	RAM U504 failed	uP RAM failed	A/D Slope Error	ROM0 checksum Error	ROM1 checksum Error	Cal RAM checksum Error
128	64	32	16	8	4	2	1
Bit Value							
Register 4: Calibration Error Register							
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Not Defined May be 1 or 0	A/D Error	Cal RAM defective	Calibration attempted but not enabled	Invalid Cal zero	Invalid Cal signal	Invalid Cal number	Invalid Cal function in range
128	64	32	16	8	4	2	1
Bit Value							

Figure 1. Status, Error, Hardware Error, and Cal Error Register Bits

**Table 1. Description of State Register 3 and 4 Bit Values**

Register	Bit #	Description
3	0	Cal RAM Checksum Error. This shows if any calibration RAM locations have incorrect checksums which can be caused if one or more calibration constants are missing or are invalid. If the bit is set in self test, it is typically caused by an uncalibrated Multiplexer/Actuator option. Perform the temperature calibration procedure for each option installed, as given in this note. If the bit is set when attempting the temperature calibration of the Multiplexer/Actuator option, continue with the calibration procedure. If, after calibration, the bit is still set, perform a complete instrument calibration. If after a complete calibration the bit is still set, go to Section VIII of the 3421A Mainframe Service Manual for troubleshooting.

**Table 1. Description of State Registers 3 and 4 Bit Values (Cont'd)**

Register	Bit #	Description
4	0	Invalid Cal Function or Range. This bit is set if the calibration constants cannot be calculated in the selected function and range. For example, If F0 (all functions off) is selected, or R-1 (.3V range) is selected with the 3421A in the F2 (ac volts) function, the bit will be set. Make sure the correct function and range combination is selected before attempting any calibration.
	1	Invalid Cal Number. This shows that an attempt was made to calibrate the 3421A with an incorrect calibration number. For example, if the number for the full scale calibration signal is NOT between 299000 and 301000 or 099000 and 101000 for the $\frac{1}{3}$ scale calibration signal, the bit will be set. Make sure the calibration signal and number are the correct values before attempting any calibration.
	2	Invalid Cal Signal This bit is set if an attempt is made to calibrate a function and range using the wrong calibration signal. For example, the bit is set if a dc volts signal is used to calibrate the ohms function. This bit can also be set when doing the temperature calibration of the Multiplexer/Actuator option. This can happen if the 3421A is unable to receive a valid signal from the temperature transducer on the option. If the bit is set during temperature calibration, make sure the option's cables, associated temperature transducer, or U102 in the 3421A mainframe are good. If the 3421A has an older A1 Assembly with HP Part Number 03421-66501, suspect the temperature sensor FETs in U102.
	3	Invalid Cal Zero. This shows that the zero calibration constant is invalid when attempting to calibrate at full or $\frac{1}{3}$ scale. Make sure the correct zero calibration has been performed before doing any full or $\frac{1}{3}$ scale calibration.
	4	Calibration Attempted But Not Enabled. This shows that an attempt was made to calibrate the 3421A with the calibration enable switch set in the disable position (S501 segment #8 in the up position). Make sure the switch is set in the calibration enable position (down) before performing any calibration.
	5	Cal RAM Defective. This shows a defective calibration RAM (U502). Go to Section VIII of the 3421A Mainframe Service Manual for troubleshooting.
	6	A/D Error This bit is only set when an A/D error shows up during calibration. It can be caused by the A/D Converter itself, an inoperative reference voltage circuitry, or the input circuitry (i.e., U102, U101, or associated circuitry). Go to Section VIII of the 3421A Mainframe Service Manual for troubleshooting.
	7	This bit is not defined and can be either 1 or 0.

## SEMI-AUTOMATED TEMPERATURE CALIBRATION, AND OTHER PROCEDURES

The semi-automated temperature calibration procedure requires the HP 3421A Calibration and Performance Test Tape Cartridge (P/N 03421-10001, Rev. C). This cartridge contains calibration and performance test routines for the HP 3421A and uses an HP-85 computer for the controller.

Besides the temperature calibration procedure, the HP 3421A mainframe, the Model 44462A Multiplexer/Actuator Assembly, and the Model 44465A Digital I/O Assembly can also be tested and calibrated using the tape. A Continuous Loop Test that repeatedly exercises the HP 3421A dc volts, ac volts, and ohms functions is also on the tape. This test is useful for detecting intermittent errors.

The built-in printer of the HP-85 is used to print a permanent record of the calibration and test results.

### NOTE

*Revision C of the HP 3421A Calibration and Performance Test Cartridge (HP P/N 03421-10001) contains major changes allowing the use of the Temperature Calibrator Board (HP P/N 03421-66505). In addition, other improvements have been implemented to provide automatic analysis of the HP 3421A state registers during the performance of the test routines. Previous revisions do not support the Temperature Calibrator Board. All users should replace previous revisions with Revision C. Due to the magnitude of the changes, simple modifications of previous revisions is not possible.*

### Recommended Equipment

The test equipment for the semi-automated procedures is listed in Table 2. The Diagnostic Terminal Block (HP P/N 03421-66504), Temperature Calibrator Board (HP P/N 03421-66505), Calibration and Performance Test Tape Cartridge (HP P/N 03421-10001, Rev. C), and a service note explaining the procedures can be ordered ■ HP P/N 03421-67901. The Temperature Calibrator Board (HP P/N 03421-66505) is presently shipped with all HP 3421As equipped with a Multiplexer/Actuator option (Option 020, 021, or 022), and all Multiplexer/Actuator Assemblies ordered separately (i.e., HP 44462A). It can also be ordered separately.

**Table 2. Recommended Test Equipment**

Instrument	Recommended Model	Use*
Digital Voltmeter	HP Model 3456A	PC
DC Voltage Standard**	Systron Donner Model M107	PC
AC Calibrator**	Fluke Model 5200A	PC
Resistance**	Guildline Model: 9330/100 or 9330A/100 9330/1K or 9330A/1K 9330/10K or 9330A/10K 9330/100K or 9330A/100K 9330/1M 9330/10M	PC
Function Generator**	HP Model 3325A	P
Computer	HP Model 85A with I/O ROM and Applications ROM HP Model 85B with I/O ROM	PC
Computer Interface	HP-IB or HP-IL	PC
HP 3421A Calibration and Performance Verification Program Tape	HP P/N 03421-10001, REV. C only	PC
Diagnostic Terminal Block**	HP P/N 03421-66504	P
Temperature Calibrator Board	HP P/N 03421-66505	C
DC Power Supply**	HP Model 6248B	P

\*P = Performance; C = Calibration  
\*\*Not Required for Temperature Calibration

### Instructions for Running the Semi-automated Procedures

To run the tape cartridge program, do the following:

- a. With the HP-85 turned off, turn the HP 3421A on.
- b. Insert the tape cartridge into the HP-85.
- c. Turn the HP-85 on.
- d. The program will now load which is indicated when the amber light on the HP-85 is on. After the amber light goes out, the program is loaded. Following the loading of the program, a brief period of inactivity follows. Do not strike any keys. The computer is, at that time, interpreting the BASIC program lines and will prompt when this is complete. When it is completed, the program will then run.

Setup diagrams for the interconnections of the various test equipment are displayed on the HP-85. Although the figures indicate that the HP 3421A is controlled over HP-IL, it can also be controlled using HP-IB, if the appropriate HP-IB option is present. Messages will also be displayed to show when the connections are to be made and, if necessary, how to manually set the sources.

### Special Function Keys

The special function keys are the major source of interaction with the program. They determine which operation is to be performed. The bottom two lines of the HP-85 display corresponds directly to the special function keys on the HP-85 keyboard. The bottom line of the display indicates the labels for the unshifted keys (K1 though K4); the upper line displays the labels for the shifted keys (K5 through K8).

### Selecting Calibration or Performance Tests

When the autostart program runs, the HP-85 displays information and instructions for selecting either calibration (cal) or performance verification (pv). After selecting one or the other, you will be asked if a copy of the equipment setup figures is required. If you do have these figures, answer yes. The appropriate diagrams and explanations are then displayed and printed out for you. Keep these for subsequent test sessions.

After the appropriate selections are made, the proper routine (either "CAL21" or "PV21") are then loaded for execution. Note that the interpretation of these lengthy programs require some time within the computer.

### Calibration

This program initially prompts the user to input the current date, the serial number of the HP 3421A to be calibrated, and the user's name. This information is used to standardize documentation of the session. After the desired information has been entered, press the END LINE key. Next, the program asks for the HP 3421A remote address (HP-IL or HP-IB). Again enter the requested information and press the END LINE key.

The next step in the calibration procedure is to set the HP 3421A rear panel calibration enable switch (S501 segment #8) to the enable position (down). The program will not proceed beyond this point if the correct switch is not enabled.

An uncalibrated slot containing a Multiplexer/Actuator Assembly causes self test 0 to fail at power on. If this occurs, press the "SKIP" special function key, clearing the error indicator and allowing you to continue.

When the calibration menu is displayed, make a selection using the special function keys. The calibration routine selected will request any additional information needed to perform the desired calibration. It also directs you in setting up the instrument.

At the end of any given routine, you can either return to the calibration menu or exit from the calibration program. Upon exiting the program, the performance tests can be run by pressing the appropriate special function keys. You will be reminded to reset the calibration enable switch to the disable (up) position before leaving the calibration program.

**Temperature Calibration.** Thermocouple reference junction calibration should be performed for each Multiplexer/Actuator Assembly that is installed. It is recommended that the temperature calibration be performed with the HP 3421A in the same physical position as it will be when used. That is, the Model 3421A should be calibrated after warming up for at least one hour while placed in the equipment orientation (rack mounted or stacked with peripherals and associated instruments) within which it will be used. Attempt to simulate this if necessary. It is important to take into account as many environmental influences upon the instrument temperature as possible.

**General Note for Operation during Calibration.** An abnormal condition might cause program or communication bus hang-up during a session. To rerun the program, do the following:

- a. Return the HP 3421A calibration enable switch (S501 segment #8) to the up position. If this is not done, the contents of the calibration RAM could be erroneously altered, requiring complete recalibration of the instrument.
- b. Press the HP 3421A front panel switch off.
- c. Press the HP-85's RESET key.
- d. Remove any connections to the HP 3421A front panel inputs and option assemblies.
- e. Press the Model 3421A front panel switch on. Wait for the instrument's self test to complete.
- f. Press the HP-85 RUN key.

### Performance Verification

This program initially prompts the user to input the current date, the serial number of the HP 3421A to be tested, and the user's name. This information is used to standardize documentation of the session results. The steps of this routine are self explanatory. To insure proper program operation, the displayed instructions for each step must be carefully read. Performance verification tests are performed for the dc volts, ac volts, ohms, and frequency functions, in addition to the option assemblies.

The *Ohms* routine checks either 2-wire or 4-wire ohms configurations. The instrument is calibrated at the factory for 4-wire ohms. If your application involves 2-wire ohms measurements, calibrate for the 4-wire ohms before running the ohms performance test.

The *Continuous Loop Test* is useful for isolating intermittent errors. It continuously tests the dc, ac, and ohms functions for each of their ranges by comparing the measurement obtained across a manually applied short at the front panel terminals with the instrument's specified tolerances. Execution is terminated by either the tenth occurrence of an out of specification reading, or by pressing the HP-85 special function key labeled "STOP". Both beginning and ending times are printed along with any function and range out of the specified limits.

The Multiplexer/Actuator and Digital I/O Assemblies can be operationally verified using the Option Assembly test and the Diagnostic Terminal Block (HP P/N 03421-66504).

### NOTE

*When installing the Diagnostic Terminal Block in slot 0, make sure that it does not unplug the grey ribbon cable adjacent to the switch block (S501) at the back of the instrument motherboard.*